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TWO-PART SOLENOID AND METHOD FOR THE MANUFACTURE THEREOF

Background Information

The present invention is based on a two-part solenoid according to the definition of the species in Claim 1, and a method for the manufacture thereof according to the definition of the species in Claim 14.

A solenoid as recited in the preamble of Claim 1 is already known from German Patent 295 14 315 U1. The solenoid includes a largely cylindrical hollow bobbin made of an insulating material that is provided with two relay connectors anchored in an end area of the bobbin and projecting axially therefrom, with it being possible to wind the bobbin mechanically. The bottom of the bobbin forming the bottom of the winding space has variable adjacent winding levels in the axial direction which are offset against one another in the radial direction, with the transitions between the winding levels being designed as a bevel having an inclination of approximately 30 degrees. Except in the transition areas, the bottom of the bobbin is provided with grooves for the winding wire.

The disadvantage of the solenoid known from German Patent 295 14 315 U1 lies, in particular, in the overall length of the solenoid, which is determined by the length of the relay connector. This makes the solenoid susceptible to damage, for example, when mechanically winding the coil wire. The relay connectors have a tendency to bend.

Another disadvantage is that different flat connectors for the electrical lines may require different manufacturing methods, which complicates the production process and makes it expensive.

Summary of the Invention

The solenoid according to the present invention having the features of Claim 1, and the method according to the present invention for the manufacture of a solenoid, having the features of Claim 14, have the advantage over the related art that the short relay connectors enable the solenoid to be easily handled in subsequent processing steps, and, in addition, a contact element of any shape, for example a flat connector, may be attached to the solenoid by a simple snap-on connection and subsequently soldered to the relay connectors.

The features described in the subordinate claims represent advantageous embodiments of the solenoid indicated in Claim 1 and the method indicated in Claim 14.

One particular advantage is the easy manufacture of the relay connectors and contact elements, which may be manufactured, for example, by punching them out of a metal sheet.

The connecting part between the solenoid and the contact element is advantageously made of a flexible plastic which enables the contact element to be mounted on the bobbin or the valve housing.

The contact tabs of the contact element are still connected during manufacturing, which makes it easier to correctly position the contact tabs relative to each other. After being extrusion-coated with plastic, the contact tabs are separated by punching.

The angled extensions of the contact tabs give the contact element a shape that allows it to be easily connected to the relay connectors.

Drawing

An exemplary embodiment of the present invention is illustrated in simplified form in the drawing and explained in greater detail in the description below, where:

Figure 1A shows a schematic top view of a relay connector of a solenoid according to the present invention,

Figure 1B shows a schematic side view of a relay connector of a solenoid according to the present invention,

Figure 1C shows a schematic section along the line of intersection marked IC-IC in Figure 1A,

Figure 2A shows a schematic view of the bobbin of a solenoid according to the present invention,

Figure 2B shows a schematic longitudinal section of the bobbin of a solenoid according to the present invention,

Figure 2C shows a detail of area IIC from Figure 2B,

Figure 3A shows a schematic cross-section of a solenoid according to the present invention,

Figure 3B shows a schematic side view according to Figure 3A,

Figures 4A-C show a schematic view of the contact element of the solenoid according to the present invention in three consecutive stages of processing, and

Figures 5A-E show a schematic representation of the method steps according to the present invention for connecting the solenoid to the contact element.

Description of the Exemplary Embodiment

Solenoid 2 according to the present invention is suitable, in particular, as a component for a fuel-injection valve like

those used, for example, to inject fuel into the combustion chamber of a mixture-compressing, internal combustion engine with externally supplied ignition.

Figures 1A-1C show a schematic representation of a relay connector 1 of a solenoid 2 according to the present invention in different views.

Figure 1A shows a top view of relay connector 1, which is needed to suitably hold in place wire ends 7 of wire 6 which is wound to form solenoid 2, so that the ends may be connected to electrical lines leading to a control unit for the fuel injection valve.

Relay connector 1 has a generally tab-like shape having side projections 25 and 26. Shorter projections 25 are used, in particular, to stabilize the position of relay connector 1 in a bobbin 3.

Projections 26 are used to widen the surface of relay connector 1 so that, after bobbin 3 has been wound, the ends of winding 5 can be attached to relay connector 1, for example by soldering.

Relay connector 1 also has holes 27 and 28, which, like projections 25 and 26, are used to fix relay connector 1 in place in bobbin 3 or to fasten wire ends 7. For example, wire ends 7 may be fed through hole 28 and then pinched. Hole 27 is filled with plastic when relay connector 1 is injected into bobbin 3, thereby securing relay connector 1 in place in bobbin 3.

Figure 1B shows a corresponding side view of relay connector 1. Due to its simple shape, relay connector 1 may be easily produced, for example, by punching it out of a metal sheet.

Figure 1C shows a cross-section along the line marked IC-IC in Figure 1A. As in the present exemplary embodiment, relay connector 1 may have rounded edges, which further simplifies processing.

Figures 2A-2C show a schematic view and a schematic longitudinal section of bobbin 3 of a solenoid 1 according to the present invention as well as a detail of the area marked IIC in Figure 2B.

Figure 2A shows a schematic side view of unwound bobbin 3 having relay connectors 1 already attached to bobbin 3. Because of their simple shape, relay connectors 1 are easily connectable to bobbin 3. Bobbin 3 is principally made of plastic by injection molding. Relay connector 1 is injected into bobbin 3 up to lateral projections 25.

Bobbin 3 has a largely cylindrical hollow design with a circumferential recess 30 for holding winding 5.

An extension 4 of bobbin 3, which forms an end area and extends the cylindrical hollow cross-section of bobbin 3 in an angular range of approximately 40^0, is molded onto bobbin 3. Relay connectors 1 are injected in one end area 31 of extension 4.

Figure 2B shows a longitudinal section of bobbin 3 of solenoid 2 according to the present invention, illustrated in a schematic sectional representation. Relay connectors 1 are attached in projecting end area 31 of extension 4 of bobbin 3.

Figure 2C shows an enlarged section of Figure 2B in area IIC for further clarification. Relay connectors 1 are inserted into extension 4 of bobbin 3 up to the point marked E in Figure 1A.

Figure 3A shows a view of the relay connector end of a solenoid 2 according to the present invention. Of a winding 5 of solenoid 2, only wire ends 7, which are wound around relay connector 1, are visible.

Figure 3B shows a side view of a solenoid 2 according to the present invention, around which winding 5 of a wire 6 is wound on bobbin 3. Wire ends 7 are routed from winding 5 of solenoid 2 via extension 4 of bobbin 3 to relay connectors 1. Wire ends 7 are routed to relay connectors 1 in an indentation 32 provided in extension 4 of bobbin 3, and they are wound around relay connectors 1 at least once in the area between projections 25 and 26 and may have flattened segments 8 for better attachment to relay connectors 1. Possible attachment methods include welding or soldering or even fixing wire ends 7 in hole 27.

Figures 4A-4C show schematic representations of three consecutive processing steps in the manufacture of a contact element 9 according to the present invention.

Figure 4A shows a schematic view of one exemplary embodiment of contact element 9, which, like relay connectors 1, is easily punchable from a metal sheet. Contact element 9 has two contact tabs 10 which have rounded front edges 11. Both contact tabs 10 are punched out in a single piece, connected by a web 12 which is removed later on. Two extensions 13 projecting outward at any angle are provided at the end of contact element 9 opposite rounded edges 11. Extensions 13 are used for connection to relay connectors 1 in a later processing step. Multiple holes 14a, 14b are provided in contact tabs 10 of contact element 9, with the present exemplary embodiment having two holes per contact tab 10.

In the next processing step, whereby contact element 9 is extrusion-coated, the plastic enters holes 14a, 14b, securely anchoring contact tabs 10 of contact element 9 in the plastic.

Figure 4B shows a schematic view of contact element 9 after contact tabs 10 have been extrusion-coated with plastic. A first plastic web 15 is formed in the area of holes 14a. The plastic enters holes 14a and holds contact tabs 10 a certain distance apart, determined by the width of web 12. A connecting part 16 according to the present invention is injection-molded onto plastic web 15. For stability, a second plastic web 19 is provided in the area of holes 14b and used to stabilize the position of contact tabs 10 relative to one another.

To electrically isolate contact tabs 10, metallic web 12 is removed by punching.

First plastic web 15 continues into connecting part 16, which was injection-molded onto contact element 9, using a suitable apparatus which is not illustrated in any further detail here. Connecting part 16 is in the shape of a hollow cylinder that is open at one end. Slightly more than half of the cylinder wall is designed as a complete hollow cylinder. Extensions 13, which will connect contact tabs 10 to relay connectors 1 later on, project laterally from plastic web 15.

Figure 4C shows a side view of the exemplary embodiment of contact element 9 illustrated in Figure 4B after a further processing step. In this processing step, contact element 9 is bent at an approximately 30-degree angle toward the horizontal at a bending point 17 in the vicinity of plastic web 15.

Figures 5A-5E show a schematic representation of the method steps for connecting solenoid 2 according to the present invention to contact element 9.

Figure 5A shows a view similar to that in Figure 3A of the relay connector end of bobbin 3. Relay connectors 1 and wire ends 7 are visible in end area 4 of bobbin 3.

Figure 5B shows the same representation of bobbin 3 after relay connectors 1 have been bent. Relay connectors 1 are preferably bent outward at a 90-degree angle from their previous position.

Figure 5C shows a side view of solenoid 2 that is already mounted on a housing body 18. Housing body 18 has an external housing 21, which encapsulates solenoid 2, and an inner housing part 22 that grips solenoid 2 and has an outer diameter equal to the inner diameter of connecting part 16. Due to the special shape of connecting part 16 according to the present invention, it may be mounted on inner housing part 22 in a stable snap-on connection. Connecting part 16 surrounds inner housing part 22 in an area which forms an angle greater than 180 degrees, preventing connecting part 16 from sliding off inner housing part 22 in the radial direction.

Figure 5D shows the same view as Figures 5A and 5B, illustrating bobbin 3, which is mounted on inner housing part 22, with connecting element 9 positioned over connecting part 16. Extensions 13 of contact tabs 10 of contact element 9 come to rest on bent relay connectors 1 of bobbin 3. First plastic web 15 of contact tabs 10 of contact element 9 has an external shape that prevents connecting part 16 from sliding on internal housing part 22.

In the final method step, as shown in Figure 5E, contact element 9 is connected to relay connectors 1 by a weld 20 or by soldering it onto extensions 13. The welding or soldering step arrests contact element 9 firmly in its final position so that it cannot move in either an axial or radial direction. This also establishes a secure electrical contact between contact element 9 and relay connectors 1.

The present invention is not limited to the illustrated exemplary embodiment, but is also suitable for a contact

element 9 having a wide variety of other shapes. According to the method, coils having multiple windings insulated against one another may be provided with a contact element of any design.